Remote Sensing and Machine Learning in action for Country Diagnostics in North Macedonia

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SUMMARY

Increasing availability of satellite data coupled with rapid advancements in machine learning techniques are producing high-resolution measurements of the pace and nature of economic change. It is now possible to readily use robust satellite-based measurements of economic trends to inform policy design and analysis.

The 2018 Systematic Country Diagnostic for North Macedonia, "Seizing a Brighter Future for All", led by Marco Antonio Hernandez Ore and Cesar A. Cancho, and working with Brad Bottoms, was the first to incorporate measurements produced by satellite imagery and machine learning algorithms to develop proxies for economic growth, urbanization, and land use in 2000-2018. In addition, these measurements were overlaid with firm-level data to approximate relationships between economic growth and firm dynamics in 2012-2016. The machine learning algorithms to produce the measurements are open for replication and reuse.

CHALLENGE

The general cutoff date for countries to report data for this publication was end-August 2018. The economic aggregates presented in the tables are prepared for the convenience of users. Although debt ratios can give useful information about developments in a debt-servicing capacity, conclusions drawn from them will not be valid unless accompanied by careful economic evaluation.
The macroeconomic data provided are collected from national statistical organizations, which in some cases may be subject to a considerable margin of error. The usual care must be taken in interpreting the ratios, particularly for the most recent years, because figures may be preliminary and subject to revision. Specific country notes describing the sources of information which are not provided by the country are summarized in the “Data Documentation” section. Unless otherwise specified, data on long-term public and publicly guaranteed external debt for 2017 are based on reports provided by the country.

More detailed information on data sources, methodology, and compilation is provided in the appendix at the back of this book.

INNOVATION

Today, the increased availability of open satellite data, combined with powerful cloud computing and open source analytics and tools have democratized data innovation, enabling local governments and agencies to use satellite data to improve sector diagnostics, development indicators, program monitoring and service delivery.

The North Macedonia analysis used publicly available satellite data and machine learning approaches to understand the spatial distribution of economic activity at much greater resolution, frequency, and scale than in comparable country diagnostics. The analysis also used a novel methodology developed by Goldblatt et al. (2018) for image classification of built-up land cover.

The public satellite data was sourced from two sensors. The Defense Meteorological Satellite Program (DMSP-OLS) which provides publicly available data dating back to 1992. The Visible Infrared Imaging Radiometer Suite (VIIRS) Day/Night Band (DNB) sensor provides publicly available data since 2012. These two satellites provide similar information but vary in resolution and time frame.

To map built-up land cover, the project used a methodology combining nighttime and daytime remotely-sensed data, collecting training samples automatically using DMSP-OLS data and using these for classification of built-up areas with daytime Landsat 30m spatial resolution imagery (Goldblatt et al., 2018). Alongside the built-up land cover mapping, trends in deforestation were calculated based on Hansen Global Forest Change v1.3 (2000-2015), a data set drawing on Landsat imagery to indicate global tree-cover extent, loss and gain. The data were analyzed to reveal the total forest cover per pixel in 2000 and the total area of forest cover lost in a given year at national and municipal levels.
The DMSP/VIIRS measurements were overlaid with from ground surveys and proprietary sources (2012-2016). The study then examined correlations in the distribution of firm activity with the nightlight proxies for urban and economic development.

**RESULTS**

The analysis produced several key findings.

- In the last two decades, Macedonia experienced extensive development processes, which are indicated by a constant increase in the intensity of nighttime light in the country.

- Municipalities in the northern part of the country experienced change in nightlight consistent with more rapid economic development – while those in eastern parts showed a more moderate change in SOL, indicating more moderate economic development.

- Between 2001 and 2014, 22.8 km² of forest cover were lost in Macedonia, on average, every year. The period between 2007 and 2009 is characterized by the highest rates of deforestation.

- The firm correlation analysis yielded strong positive correlation, ~.680, between the sum of light (SOL), indicating with some confidence that when firm count increases in an area the nighttime light activity
increases as well. Saraj municipality displays how this correlation works.

**LESSONS LEARNED**

- Open and collaborative coding practices are enabling replication and reuse of analytics, tools, and learning that are contributing to rapid advancements in satellite measurements of economic development.
- Cloud based computational platforms (Google Earth Engine) can lower costs. Analysis of large-scale remotely sensed data is challenging and computationally expensive.
- Automation of satellite measurements for economic activity can be produced from algorithms that use monthly of VIIRS data.
- Intercalibration methods (Eldridge et al) enable the use of DMSP and VIIRS data to create robust time series proxies of economic activity (2000-present).
- Earth-observation data offers ground-breaking ways to monitor the spatial distribution of economic activity and its changes over time, even without access to local ground-sourced data.